Defense Information Systems Agency

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Virtualization

17 August 2011

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Why Virtualize?

- **Why is there so much hype about virtualization, and now "Cloud Computing?"**
  1) **Because it does really cool things, and**
  2) **Because it does vitally important, boring things**
- **Another way to phrase these statements is:**
  1) **Because we want to, and**
  2) **Because we have to**

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Why We Want to Virtualize

- **Separates the Operating System from the physical hardware**
  - **Live migration from one physical server to another**
  - **Live migration from one storage medium to another**
  - **Develop on a $500 desktop that looks 100% equivalent to a $20,000 server**
  - **Package and ship the server as a file to the DECC to be imported and STIG'd**

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Why We Want to Virtualize

- Gives smaller workloads enterprise hardware and capabilities
  - Massive redundancy (power, network, storage, etc.)
  - Nearly limitless growth
  - Eliminates protracted outages due to hardware failure
- Fast provisioning
  - No need to keep racks of spare servers available
  - Capacity on hand to provision moderate workloads at will

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Why We Have to Virtualize

- **Nearly all of the workloads running in the DoD cannot fully utilize the hardware they are provided.**
- **Convergence of 3 factors**
  - **Separation of server functions into separate operating systems**
  - **Inability of non-concurrent, 32-bit applications to use resources**
  - **Physics of processor design**

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Separation of Functions

- Originally purchased a server to run the full stack of an application
- Then a single server produced management and scalability issues
- Finally, a single server caused security risks
- End result, nearly all functions are split amongst different tiers of servers

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Inability to Use Resources

- Splitting the functions up on different servers may have improved performance
- Applications use same resources they used before, but the OS does not have to track the different workloads
- Most servers are 1 or 2 CPU running non-concurrent, 32-bit applications
- Subsequent hardware upgrades provide faster and faster processors which results in near linear performance improvements
- Until 2005…

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Physics of Processors

- Intel and AMD begin releasing dual-core processors
- Dual-core processor is 2.66ghz, not 5.32ghz
- Microsoft and Oracle effectively ignore cores
- Moore's Law – Number of transistors on a processor doubles every 2 years
- Speed of processors doubling every 2 years is not Moore's Law, but is effectively true until 2005

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Why We Have to Virtualize

- Nearly all x86 workloads are:
  - Non-concurrent
  - 32-bit based
  - Separated at the OS level by function
- Smallest physical server available with a fast processor is 12-cores (2 CPU with 6 cores per CPU) and 8GB of RAM
- The best a non-concurrent, 32-bit application can use of this server is 8.3% of CPU and 20% of RAM
- x86 Virtualization came to prominence in roughly 2005

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How Does CSD Virtualize

- UNIX
  - HP-UX – Integrity Virtual Machines
  - Solaris OLTP – Oracle VM Server for SPARC (Ldoms)
  - Solaris Other – Limited use of Zones/Containers
- x86
  - Currently:
    - VMWare vSphere ESX
    - HP 2 socket servers (BL490c and DL380)

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x86 Virtualization

- **Built for robust, consistent operation of nearly all workloads**
  - **One type of server**
  - **One type of storage**
  - **Redundancy everywhere possible**
  - **Sustain the loss of a single host within a cluster without disruption**
- **Provisioning is at 1 vCPU and 2GB of RAM**
  - **Servers are grown dependent upon usage**
  - **Most resources can be added while the server is running**

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The State of x86

- 2100+ Virtual Operation Environments (VOEs)
- 257 VMWare vSphere 4.0 ESX Hosts in Operation
- 41 Clusters around the world
- 400+TeraBytes of DataStores
- Size Distribution of VOEs:
  - vMemory:
    - <2GB – 50%
    - 2-4GB – 41%
    - >4GB – 9%
  - vCPU:
    - 1 – 55%
    - 2 – 44%
    - >2 – <1%

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Backup Slides

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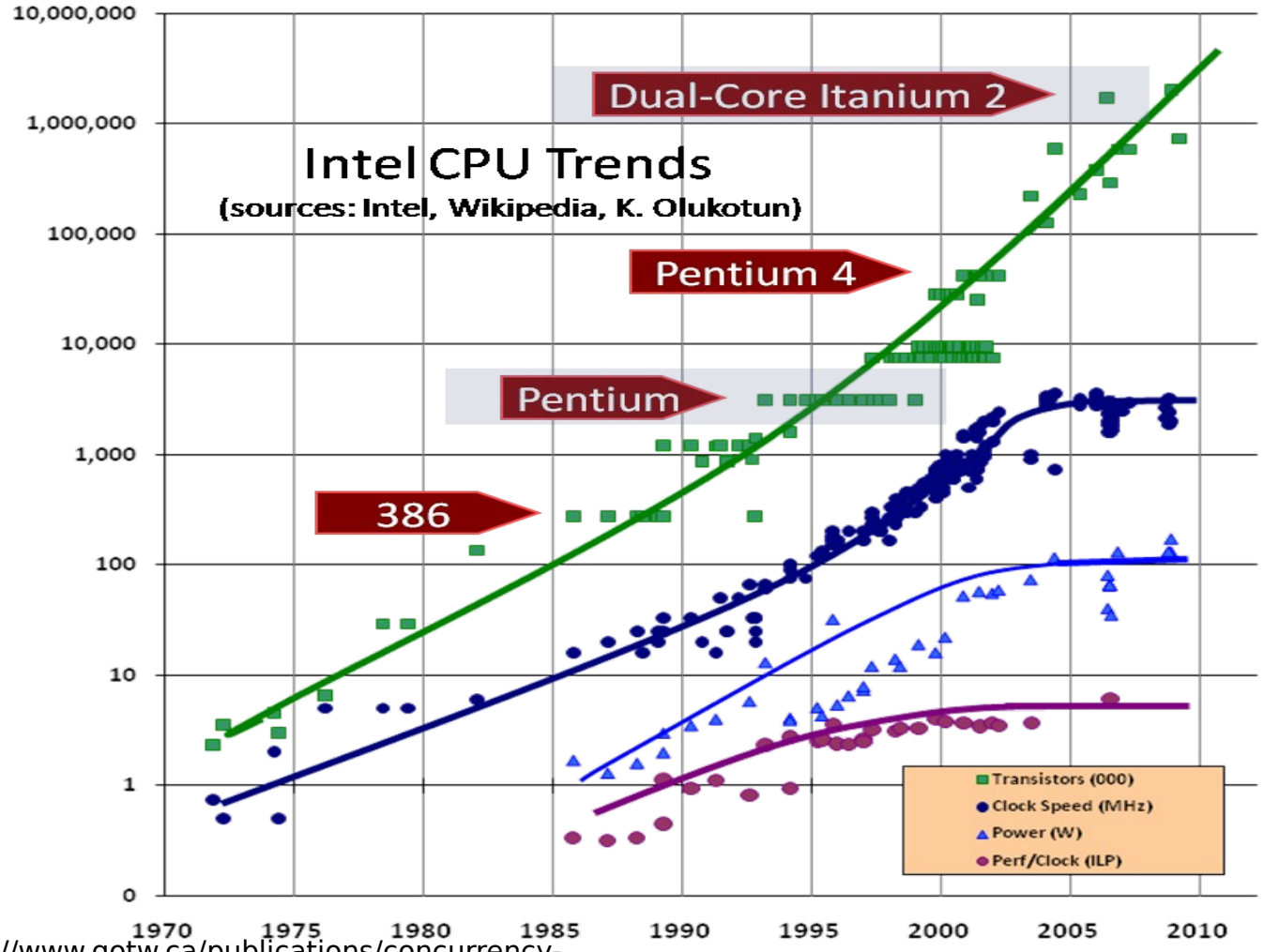

Source: http://www.gotw.ca/publications/concurrency-ddj.htm

The speed of an x86 processing core has not increased since 2005.

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	August-2010		September-2010		October-2010		November-2010		December-2010		January-2011	
Model	**CPU %**	**Mem %**	**CPU %**	**Mem %**	**CPU %**	**Mem %**	**CPU %**	**Mem %**	**CPU %**	**Mem %**	**CPU %**	**Mem %**
PROLIANT BL460C	0.22	22.521	0.15	21.584	0.23	21.166	0.27	22.598	0.41	22.15	2.11	24.874
PROLIANT BL460C	1.32	49.965	0.52	38.886	0.62	34.917	0.66	31.37	0.60	38.15	0.63	52.443
PROLIANT BL460C	13.78	56.606	13.03	55.508	13.09	45.282	13.18	35.259	13.08	53.435	13.11	51.506
PROLIANT DL380G6	0.32	21.594	0.57	17.395	1.49	26.868	0.81	23.944	0.89	26.792	0.61	27.484
PROLIANT DL380G6	0.35	21.459	0.47	17.888	0.68	20.116	0.73	19.283	0.63	19.117	0.95	25.23
PROLIANT DL380G6	0.32	20.286	0.78	17.219	0.65	20.396	0.79	19.61	0.52	19.408	0.51	20.271
PROLIANT DL380G6	0.08	14.959	0.14	13.026	0.23	16.712	0.20	16.33	0.20	20.365	0.20	25.273
PROLIANT BL460C	8.34	17.982	8.34	18.285	8.34	19.263	0.71	19.353	0.15	21.352	0.02	20.904
ProLiant BL460c G1	2.08	11.178	1.95	13.658	2.00	14.766	1.99	12.803	1.91	13.064	1.87	13.082
PROLIANT BL460C	0.55	17.279	0.53	18.144	0.54	18.535	0.53	19.62	0.49	19.33	0.47	19.105
PROLIANT BL460C	0.67	12.435	0.73	13.643	1.14	20.116	1.22	14.196	4.34	17.602	1.73	15.624
PROLIANT BL460C	0.43	12.018	0.76	13.259	0.42	11.539	0.42	11.539	0.42	11.539	0.97	12.133
PROLIANT BL460C	0.35	12.045	0.29	11.053	0.37	10.691	0.44	11.556	0.56	11.667	0.99	11.845
PROLIANT BL460C	4.79	31.294	6.43	33.351	7.23	31.232	5.49	29.724	6.70	32.085	6.96	31.12
PROLIANT BL460C	1.92	38.478	2.92	48.688	11.00	45.47	8.46	43.84	4.73	42.12	2.51	42.219
PROLIANT BL460C	4.91	40.405	11.33	43.443	10.59	41.277	10.51	39.537	4.75	41.969	5.12	40.468
PROLIANT BL460C	7.81	41.812	1.89	42.518	7.52	45.22	1.91	42.405	1.71	40.357	1.63	39.468
PROLIANT BL460C	0.85	16.133	0.91	18.404	0.89	20.583	0.91	16.24	0.87	16.15	0.86	15.785
ProLiant BL460c G1	1.00	35	0.63	28.807	0.68	11.351	0.64	12.009	0.75	10.783	0.89	11.163
ProLiant BL460c G1	0.96	34.88	0.70	37.198	0.68	27.796	0.66	13.35	0.83	12.52	4.07	10.646
ProLiant BL460c G1	0.92	6.535	0.82	6.476	0.83	7.436	0.82	6.476	0.83	7.436	1.18	12.475
ProLiant BL460c G1	0.90	6.676	0.84	6.374	1.46	9.173	1.01	9.497	0.97	6.896	0.85	6.665
ProLiant BL460c G1	0.86	6.679	1.02	7.563	0.84	6.346	0.83	6.931	0.89	7.645	1.41	8.809
ProLiant BL460c G1	0.96	9.633	0.88	8.295	1.21	10.797	1.12	13.218	1.04	12.434	0.85	9.034
ProLiant BL460c G1	1.24	8.482	0.76	8.219	0.96	8.335	0.96	8.335	0.93	8.409	1.15	7.993
PROLIANT BL460C	0.69	13.196	0.63	13.322	0.69	13.182	0.63	13.322	0.69	13.182	0.82	13.921
PROLIANT BL460C	0.78	11.631	1.11	12.212	0.67	12.152	0.67	12.341	0.71	12.467	0.60	14.801
PROLIANT BL460C	1.16	32.61	0.97	44.224	1.38	46.146	5.22	84.673	6.03	77.807	5.78	67.043
PROLIANT BL460C	1.48	56.126	3.87	68.56	2.63	73.501	1.01	37.994	0.78	37.703	3.10	27.141
PROLIANT BL460C	0.63	14.912	0.60	17.255	0.78	19.148	0.82	20.056	0.78	19.148	0.82	20.056
PROLIANT BL460C	0.60	14.33	0.60	11.536	0.75	11.926	0.75	11.926	0.57	12.576	0.58	13.107
PROLIANT BL460C	0.61	12.152	0.55	12.725	0.62	12.54	0.55	12.725	0.62	12.54	0.62	13.381
PROLIANT BL460C	0.70	11.962	0.64	13.367	0.70	15.449	0.72	13.322	0.75	12.632	0.76	14.26
PROLIANT BL460C	3.70	41.668	6.26	46.682	5.62	42.566	7.31	45.179	6.74	43.887	7.90	49.247
ProLiant BL460c G1	0.82	39.508	0.77	42.102	0.92	40.569	1.40	44.218	1.27	44.832	1.28	43.287
ProLiant BL460c G1	5.23	24.416	4.81	27.189	4.72	27.122	5.36	23.537	5.51	25.065	5.43	25.596
PROLIANT BL460C	0.05	2.092	0.13	2.436	0.60	3.296	0.74	3.884	0.28	4.199	0.71	7.008

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ProLiant BL460c G1	7.52	65.67	16.68	54.166	7.02	62.844	7.51	60.544	7.34	61.626	6.86	57.368
ProLiant BL460c G1	11.93	46.504	6.73	25.807	6.21	25.84	6.21	25.84	9.20	23.428	7.74	23.685
ProLiant BL460c G1	4.54	11.506	4.94	11.212	5.79	11.369	5.51	11.365	4.81	11.637	6.54	11.542
ProLiant BL460c G1	2.92	25.566	2.69	19.897	0.64	14.358	3.26	17.794	2.57	20.541	3.14	21.831
ProLiant BL460c G1	7.17	47.158	6.68	53.539	7.12	52.171	5.09	28.035	4.78	30.692	7.37	46.711
ProLiant BL460c G1	10.94	45.912	8.07	34.743	8.77	29.632	16.69	70.925	17.75	75.64	18.70	52.709
ProLiant BL460c G1	3.05	34.279	2.97	36.8	2.82	39.208	2.83	29.112	2.83	29.112	2.39	27.818
ProLiant BL460c G1	3.90	25.555	1.11	20.015	1.52	15.44	2.65	20.843	2.64	23.761	2.65	24.091
ProLiant BL460c G1	3.39	45.629	3.52	48.744	3.36	47.521	3.97	50.08	3.97	50.08	3.46	41.189
ProLiant BL460c G1	1.97	41.467	2.38	47.612	2.21	42.469	2.34	42.382	2.11	41.313	1.95	42.739
ProLiant BL460c G1	1.58	36.134	1.63	37.697	1.61	35.074	1.61	37.56	1.61	37.56	1.53	36.177
PROLIANT BL460C	1.07	14.07	1.17	13.387	1.26	13.321	1.61	13.592	1.34	13.658	1.19	12.953
ProLiant BL460c G1	3.76	11.515	2.91	11.245	2.73	11.313	3.06	12.173	2.69	12.108	2.24	11.426
ProLiant BL460c G1	9.31	38.635	9.55	35.278	10.39	36.648	10.69	42.078	9.11	35.046	10.64	37.425
ProLiant BL460c G1	2.20	35.379	2.68	60.611	2.37	59.096	2.43	59.912	1.96	61.798	2.32	53.799
ProLiant BL460c G1	2.73	24.132	2.76	23.766	2.81	23.855	2.69	24.983	1.88	25.83	1.88	25.83
PROLIANT BL460C	0.63	16.374	3.00	24.903	3.58	32.102	3.32	32.318	4.93	41.306	5.27	42.561
PROLIANT BL460C	12.47	73.044	6.80	66.215	7.35	54.863	2.14	62.69	9.04	42.265	9.66	41.496
PROLIANT BL460C	3.25	68.322	5.73	67.271	2.99	59.721	3.69	62.865	1.33	32.066	2.44	63.472
PROLIANT DL380G6	0.23	21.125	0.20	21.241	0.19	21.643	0.18	21.605	0.22	20.097	0.19	21.615
PROLIANT BL460C	0.57	27.164	0.50	27.771	0.55	28.877	0.54	29.009	0.53	29.685	0.52	32.717
PROLIANT BL460C	4.52	26.565	8.85	28.017	0.75	23.793	1.57	28.962	0.78	22.678	0.53	20.062
PROLIANT BL460C	0.57	22.435	0.56	23.63	0.60	22.783	0.63	27.674	0.61	25.507	0.56	22.158
PROLIANT BL460C	0.55	24.005	0.54	23.988	0.61	22.872	0.61	25.213	0.59	24.436	0.56	21.777
ProLiant BL460c G1	1.89	23	1.77	23.918	1.74	24.584	1.78	22.467	1.85	21.676	1.96	22.584
ProLiant BL460c G1	1.00	42.711	0.93	59.021	1.09	54.64	1.16	37.472	1.44	58.553	1.37	53.136
ProLiant BL460c G1	1.09	55.547	0.63	37.191	0.82	43.382	1.07	57.653	0.95	28.758	0.90	36.152
PROLIANT BL460C	1.87	20.538	1.78	21.065	1.91	20.471	0.56	12.685	1.32	21.805	1.42	23.561
PROLIANT BL460C	1.11	33.666	0.89	33.484	1.26	33.891	1.00	32.418	1.09	31.623	0.43	24
PROLIANT BL460C	1.11	33.204	0.91	33.445	1.27	32.861	0.95	34.033	1.19	32.148	0.69	26.679
PROLIANT BL460C	0.84	35.973	0.85	32.415	1.15	34.281	0.90	33.438	1.12	33.496	1.12	33.592
PROLIANT BL460C	1.46	19.546	4.54	20.092	14.85	18.212	0.37	15.461	1.25	58.515	1.17	30.307
PROLIANT BL460C	1.30	17.691	3.93	17.904	5.24	17.071	0.51	15.522	1.00	31.446	1.18	34.46
PROLIANT BL460C	1.03	36.437	0.66	36.475	1.16	36.857	0.71	37.912	1.10	35.381	0.97	36.41
PROLIANT BL460C	1.14	32.941	0.95	33.364	1.20	32.698	0.76	30.851	1.27	39.284	1.29	41.338
PROLIANT DL380G6	6.49	22.558	6.50	23.053	6.49	22.62	6.50	21.46	6.49	21.494	9.27	21.713

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